

APPENDIX G: LTE DOWNLINK CA RF CONDUCTED POWERS

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number of component carriers (CCs) supported by the product implementation. Per April 2018 TCBC Workshop Notes, the following test reduction methodology was applied to determine the combinations required for conducted power measurements.

LTE DLCA Test Reduction Methodology:

- The supported combinations were arranged by the number of component carriers in columns.
- Any limitations on the PCC or SCC for each combination were identified alongside the combination (e.g. CA_2A-2A-4A-12A, but B12 can only be configured as a SCC).
- Power measurements were performed for "supersets" (LTE CA combinations with multiple components carriers) and any "subsets" (LTE CA combinations with fewer component carriers) that were not completely covered by the supersets.
- Only subsets that have the exact same components as a superset were excluded for measurement.
- When there were certain restrictions on component carriers that existed in the superset that were not applied for the subset, the subset configuration was additionally evaluated.
- Both inter-band and intra-band downlink carrier aggregation scenarios were considered.
- Downlink CA combinations for SISO and 4x4 Downlink MIMO operations were measured independently, per May 2017 TCBC Workshop notes.

Table G-1 – Example of Exclusion Table for SISO Configurations

Index	CC	Supported Channel Bandwidth (MHz)	Restriction	Completely Covered by Measurement Superset	Index	CC	Supported Channel Bandwidth (MHz)	Restriction	Completely Covered by Measurement Superset	Index	CC	Supported Channel Bandwidth (MHz)	Restriction	Completely Covered by Measurement Superset	Index	CC	Supported Channel Bandwidth (MHz)	Restriction	Completely Covered by Measurement Superset					
CC#1	CA_2A	5, 10, 15, 20		Yes	CC#1	CA_2A-2A-4A	5, 10, 15, 20, 5, 10, 15, 20		Yes	CC#1	CA_2A-2A-5A	5, 10, 15, 20, 5, 10, 15, 20		Yes	CC#1	CA_2A-2A-5A	5, 10, 15, 20, 5, 10, 15, 20		Yes	CC#1	CA_2A-2A-5A	5, 10, 15, 20, 5, 10, 15, 20		Yes

Table G-2 – Example of Exclusion Table for 4x4 Downlink MIMO Configurations

Index	ZCC	Supported Channel Bandwidth (MHz)			Restriction	Completely Covered by Measurement Superset	Index	ZCC	Supported Channel Bandwidth (MHz)			Restriction	Completely Covered by Measurement Superset	Index	ZCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset
		CC1	CC2	CC3					CC1	CC2	CC3					CC4					
CC#M1	CA [2C]	5, 10, 15, 20	5, 10, 15, 20		Yes	CC#M1	CA [2A]-2A-4A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC#M1	CA [2A]-5A-66A	5, 10, 15, 20	5, 10	5, 10	5, 10, 15, 20		No	

Note: [CC] indicates component carrier with 4x4 DL MIMO antenna configuration

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G.1 LTE Downlink Only Carrier Aggregation Test Selection and Setup

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number component carriers (CCs) supported by the product implementation. For those configurations required by April 2018 TCBC Workshop Notes, conducted power measurements with LTE Carrier Aggregation (CA) (downlink only) active are made in accordance to KDB Publication 941225 D05Av01r02. The RRC connection is only handled by one cell, the primary component carrier (PCC) for downlink and uplink communications. After making a data connection to the PCC, the UE device adds secondary component carrier(s) (SCC) on the downlink only. All uplink communications and acknowledgements remain identical to specifications when downlink carrier aggregation is inactive on the PCC. Additional conducted output powers are measured with the downlink carrier aggregation active for the configuration with highest measured maximum conducted power with downlink carrier aggregation inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

Per FCC KDB Publication 941225 D05Av01r02, no SAR measurements are required for carrier aggregation configurations when the maximum average output power with downlink only carrier aggregation active is not more than 0.25 dB higher than the average output power with downlink only carrier aggregation inactive. All bands required for SAR testing per FCC KDB procedures were considered. Based on the measured maximum powers below, no additional SAR tests were required for DLCA SAR configurations.

General PCC and SCC configuration selection procedure

- PCC uplink channel, channel bandwidth, modulation and RB configurations were selected based on section C)3)b)ii) of KDB 941225 D05 V01r02. All LTE bandwidth conducted powers needed for PCC uplink configuration selection can be found in RF Conducted Powers Section and LTE/NR Lower Bandwidth RF Conducted Powers Appendix. The downlink PCC channel was paired with the selected PCC uplink channel according to normal configurations without carrier aggregation.
- To maximize aggregated bandwidth, highest channel bandwidth available for that CA combination was selected for SCC. For inter-band CA, the SCC downlink channels were selected near the middle of their transmission bands. For contiguous intra-band CA, the downlink channel spacing between the component carriers was set to multiple of 300 kHz less than the nominal channel spacing defined in section 5.4.1A of 3GPP TS 36.521. For non-contiguous intra-band CA, the downlink channel spacing between the component carriers was set to be larger than the nominal channel spacing and provided maximum separation between the component carriers.
- All selected PCC and SCC(s) remained fully within the uplink/downlink transmission band of the respective component carrier.

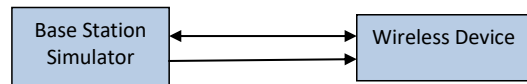


Figure G-1
DL CA Power Measurement Setup

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G.3 DL CA with DL 4x4 MIMO RF Conduction Powers

This device supports downlink 4x4 MIMO operations for some LTE bands. Uplink transmission is limited to a single output stream. When carrier aggregation was applicable, the general test selection and setup procedures described in Section G.1 were applied.

Per May 2017 TCB Workshop Notes, SAR for 4x4 DL MIMO was not needed since the maximum average output power in 4x4 DL MIMO mode was not more than 0.25 dB higher than the maximum output power with 4x4 DL MIMO inactive. Additionally, SAR for 4x4 MIMO Downlink Carrier Aggregation was not needed since the maximum average output power in 4x4 MIMO Downlink Carrier Aggregation mode was not more than 0.25 dB higher than the maximum output power with 4x4 MIMO Downlink and downlink carrier aggregation inactive.

G.3.1 LTE 4x4 MIMO DL Standalone Powers

Table G-15
Maximum Output Powers - Antenna 1b

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
7	5	21425	2567.5	16QAM	1	12	12.00	11.79	11.4

Table G-16
Maximum Output Powers - Antenna 2

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
25	5	26365	1882.5	256QAM	1	12	15.05	14.91	14.5

Table G-17
Maximum Output Powers - Antenna 3b

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
41	20	40620	2593	QPSK	50	25	14.20	14.17	14.0

Table G-18
Maximum Output Powers - Antenna 4

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
66	10	132022	1715	16QAM	1	49	14.96	14.78	14.6
30	10	27710	2310	QPSK	25	12	14.39	14.36	14.5
48	5	56715	3697.5	64QAM	1	12	12.60	12.56	11.9

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G.4 Additional Downlink Carrier Aggregation with Uplink Carrier Aggregation Enabled

This device supports uplink carrier aggregation (ULCA) with additional Carrier Aggregation configurations active in the downlink. Power measurements were performed with ULCA active and additional CA configurations active in the downlink for the configuration per Fall 2017 TCB Workshop Notes.

Per FCC Guidance, additional SAR measurements for these configurations were not required since their maximum output power was not more than 0.25 dB higher than the maximum output power for with only CA_7C, CA_41C, or CA_48C ULCA active.

G.4.1 Additional DL Carrier Aggregation RF Conducted Powers with Uplink Carrier Aggregation Enabled

Table G-31
Maximum Output Powers LTE Band 41

Combination	PCC										SCC1										SCC2										SCC3										SCC4										Power	
	PCC Band	PCC BW [MHz]	PCC [UL] Ch.	PCC [UL] Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	Mod.	SCC UL# RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	Mod.	SCC UL# RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	ULCA Tx Power with DL CA Enabled (dBm)	ULCA Tx Power (dBm)											
CA_41C41A	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										
CA_41C41B	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										
CA_41C41C	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										
CA_41E	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										
CA_41C41D	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										
CA_41C41E	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	LTE B41	20	40020	2503	15.33	15.23										

Table G-32
Maximum Output Powers LTE Band 48

Combination	PCC										SCC1										SCC2										SCC3										Power	
	PCC Band	PCC BW [MHz]	PCC [UL] Ch.	PCC [UL] Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	Mod.	SCC UL# RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	Mod.	SCC UL# RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	ULCA Tx Power with DL CA Enabled (dBm)	ULCA Tx Power (dBm)					
CA_48D	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	LTE B48	20	56405	3666.5	QPSK	50	0	56405	3666.5	LTE B48	20	56009	3626.9	QPSK	50	0	56009	3626.9	LTE B48	20	56009	3626.9	LTE B48	20	55811	3607.1	12.05	11.97					
CA_48E	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	LTE B48	20	56405	3666.5	QPSK	50	0	56405	3666.5	LTE B48	20	56009	3626.9	QPSK	50	0	56009	3626.9	LTE B48	20	56009	3626.9	LTE B48	20	55811	3607.1	12.18	11.97					

G.4.2 Additional 4x4 MIMO DL Carrier Aggregation RF Conducted Powers with Uplink Carrier Aggregation Enabled

Note: 4x4 DL MIMO is only operating in the downlink. Uplink transmission is limited to a single output stream for each component carrier of ULCA.

Table G-33
Maximum Output Powers LTE Band 7

Combination	PCC										SCC1										Power	
	PCC Band	PCC BW [MHz]	PCC [UL] Ch.	PCC [UL] Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with DL CA Enabled (dBm)	ULCA Tx Power (dBm)					
CA_7[C]	LTE B7	20	20850	2510	QPSK	1	99	2850	2630	4x4	LTE B7	20	21048	2529.8	QPSK	1	0	3048	2649.8	4x4	15.50	15.55

Table G-34
Maximum Output Powers LTE Band 41

Combination	PCC										SCC1										SCC2										SCC3										SCC4										Power	
	PCC Band	PCC BW [MHz]	PCC [UL] Ch.	PCC [UL] Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [UL] Ch.	SCC [UL] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with DL CA Enabled (dBm)	ULCA Tx Power (dBm)										
CA_41C41A	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						
CA_41C41B	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						
CA_41C41C	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						
CA_41E	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						
CA_41C41D	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						
CA_41C41E	LTE B41	20	38750	2506	QPSK	50	50	38750	2506	4x4	LTE B41	20	39948	2525.8	QPSK	50	0	39948	2525.8	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	QPSK	50	0	40020	2503	4x4	LTE B41	20	40020	2503	15.33	15.23						



Table G-35
Maximum Output Powers LTE Band 48

Combination	PCC										SCC1					SCC2					SCC3					Power						
	PCC Band	PCC BW [MHz]	PCC [U] Ch.	PCC [U] Freq. [MHz]	Mod.	PCC UL RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	Mod.	SCC UL RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with DL CA Enabled (dBm)	ULCA Tx Power (dBm)
CA_148C	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	4x4	LTE B48	20	56485	3666.5	QPSK	50	0	56485	3666.5	4x4	LTE B48	20	56207	3646.7	4x4	LTE B48	20	56207	3646.7	4x4	12.03	11.97
CA_148D	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	4x4	LTE B48	20	56485	3666.5	QPSK	50	0	56485	3666.5	4x4	LTE B48	20	56207	3646.7	4x4	LTE B48	20	56207	3646.7	4x4	11.96	11.97
CA_148E	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	4x4	LTE B48	20	56485	3666.5	QPSK	50	0	56485	3666.5	4x4	LTE B48	20	56207	3646.7	4x4	LTE B48	20	56207	3646.7	4x4	12.00	11.97

G.5 Downlink Carrier Aggregation with Inter-band Uplink Carrier Aggregation enabled

This device supports inter-band uplink carrier aggregation (ULCA) with additional Carrier Aggregation configurations active in the downlink. Power measurements were performed with inter-band ULCA active and additional CA configurations active in the downlink for the configuration per Fall 2017 TCB Workshop Notes.

Per FCC Guidance, additional SAR measurements for these configurations were not required since their maximum output power was not more than 0.25 dB higher than the maximum output power for with only ULCA active.

G.5.1 DL Carrier Aggregation RF Conducted Powers

Table G-36
Maximum Output Powers

Combination	PCC										SCC1					SCC2					SCC3					SCC4					Power	
	PCC Band	PCC BW [MHz]	PCC [U] Ch.	PCC [U] Freq. [MHz]	Modulation	PCC UL RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	Modulation	SCC UL RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with DL CA active (dBm)	ULCA Tx Power (dBm)
CA_148A	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	4x4	LTE B48	20	56485	3666.5	QPSK	50	0	56485	3666.5	4x4	LTE B48	20	56207	3646.7	4x4	LTE B48	20	56207	3646.7	4x4	12.03	11.97

G.5.2 DL Carrier Aggregation with DL 4x4 MIMO RF Conducted Powers

Note: 4x4 DL MIMO is only operating in the downlink. Uplink transmission is limited to a single output stream for each component carrier of ULCA.

Table G-37
Maximum Output Powers

Combination	PCC										SCC1					SCC2					SCC3					SCC4					Power	
	PCC Band	PCC BW [MHz]	PCC [U] Ch.	PCC [U] Freq. [MHz]	Modulation	PCC UL RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	Modulation	SCC UL RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [U] Ch.	SCC [U] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with DL CA active (dBm)	ULCA Tx Power (dBm)
CA_148A	LTE B48	20	56207	3646.7	QPSK	50	50	56207	3646.7	4x4	LTE B48	20	56485	3666.5	QPSK	50	0	56485	3666.5	4x4	LTE B48	20	56207	3646.7	4x4	LTE B48	20	56207	3646.7	4x4	12.03	11.97

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